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ABSTRACT

This student module on mechanized off-road equipment safety is one of 50 modules concerned with job safety and health. This module aims to encourage the development of a positive approach to safety as it concerns the heavy equipment industry. Following the introduction, 15 objectives (each keyed to a page in the text) the student is expected to accomplish are listed (e.g., Discuss operator qualifications and training). Then each objective is taught in detail, sometimes accompanied by illustrations. Learning activities are included. A list of references and answers to learning activities complete the module. (CT)

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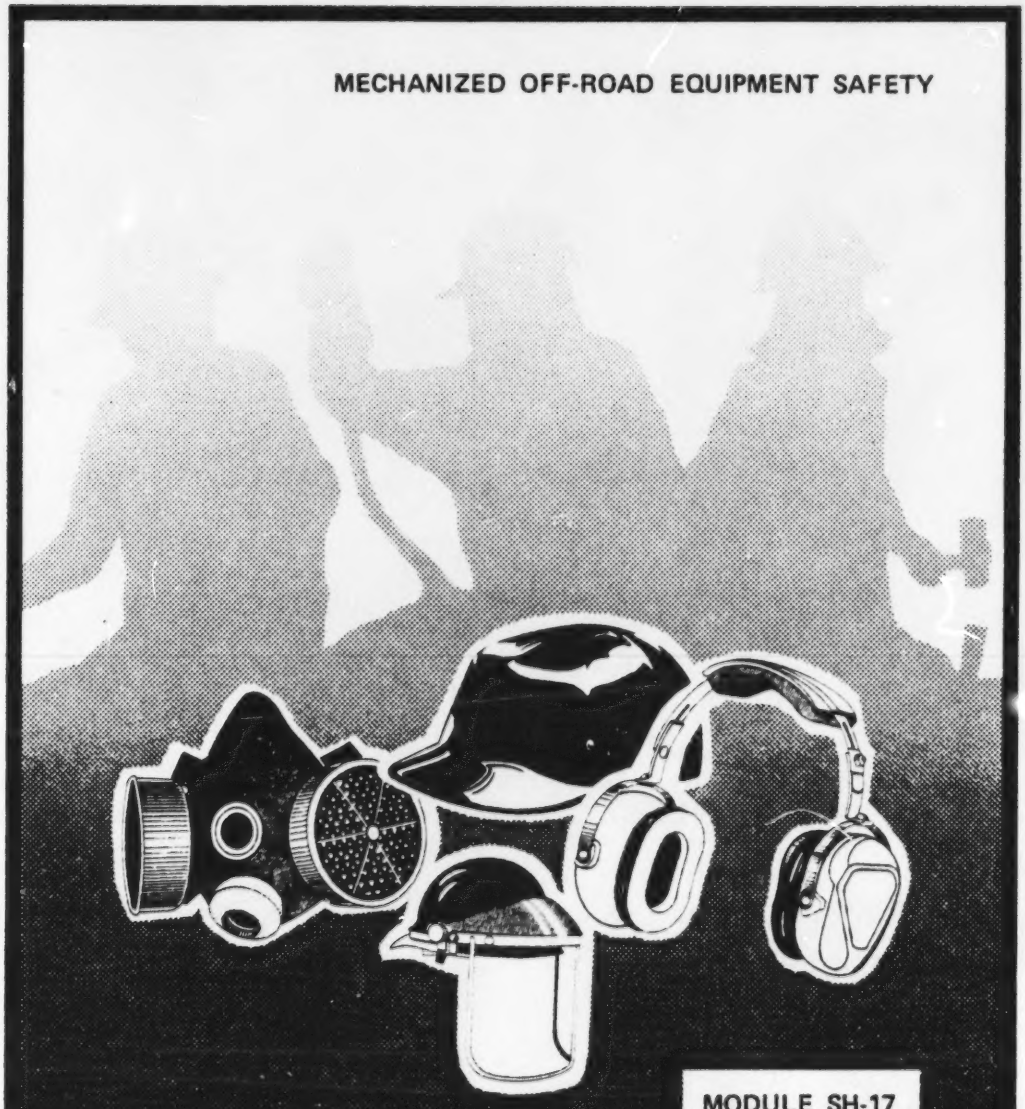
SAFETY AND HEALTH

MECHANIZED OFF-ROAD EQUIPMENT SAFETY



MODULE SH-17

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INTRODUCTION

For many years, the heavy equipment operations industry was known for high accident rates and unsafe working conditions. The operators of heavy equipment were frequently untrained in all but rudimentary operating techniques, and so were unaware of the many hazards likely to be encountered in such work. Equipment that was poorly designed and maintained contributed to accidents, as did a general disregard for the practice of safety.

Many unsafe practices have now been eliminated by both preventive and corrective measures. The institution of job-site surveys has lowered the risk of utility lines being damaged, and the practice of barricading off the work area has decreased the hazards to the general public. Training courses for operators have raised their awareness of hazards and their capabilities for handling them. The designing of equipment with safety as well as performance in mind has decreased the number of accidents and deaths from roll-overs. The single most significant factor, however, in increasing the safety of those involved in the heavy equipment operations industry, is the general increase in safety awareness. Finally, industry, labor, and government have realized that the prevention of accidents is both humane and economically sensible.

This module aims to encourage the development of a positive approach to safety as it concerns the heavy equipment industry.

OBJECTIVES

Upon completion of this module, the student should be able to:

1. Describe the function and results of a job-site survey conducted before heavy off-road equipment is used. (Page 3)
2. Cite at least five items that must be considered and perhaps protected before equipment is started. (Page 4)
3. State the purpose and process of the review and recommendation cycle of surveyed hazards and unsafe conditions. (Page 8)

4. Describe the way in which an employee awareness program works. (Page 9)
5. Identify the type and extent of the medical and first-aid support that should be available before working with off-road equipment. (Page 10)
6. Name four hazards and their corrections, or preventive measures pertaining to the use of haul roads. (Page 11)
7. Discuss operator qualifications and training. (Page 13)
8. List three safety precautions to be used when operating trucks near workers. (Page 15)
9. List three good practices to be employed when driving on dumps. (Page 16)
10. Describe the uses of each of the five types of protective equipment for heavy equipment. (Page 18)
11. List three problems encountered when transporting workers on heavy equipment and trucks. (Page 19)
12. List three safe practices to use when towing. (Page 20)
13. Discuss three procedures valuable to safety concerning power shovels, cranes, and similar equipment. (Page 21)
14. Discuss safety practices when handling loads with mobile cranes. (Page 24)
15. Discuss the use of personal protective equipment when operating motor-graders, bulldozers, and scrapers. (Page 27)

SUBJECT MATTER

OBJECTIVE 1: Describe the function and results of a survey conducted before heavy off-road equipment is used.

Working conditions and job tasks in the construction industry vary with each job site. The composition of the soil, the presence and type of timber to be cleared, and the existence of surrounding structures and utilities are some of the important factors that affect construction operations. Before equipment is selected and work started, a complete survey of the job site must be made, and all of these factors must be considered. This survey should be conducted by someone with experience and authority, usually the job superintendent or the grade or project foreman, with engineers assisting. Job safety should be uppermost in the minds of those conducting the survey. A set of project plans should be available for reference as the survey work is being done.

Barricades are the first warning to the public that some type of construction will be going on in the area. A federal or state highway project will have included in its plans the specifications for construction and location of the project and the color and type of signal lights, signs, or flares that will be used. Careful attention will be given to the flow of traffic through the project area, where applicable. All the proper types of barricades, warning lights, temporary speed limit signs, warning of machinery operations, and many other special safety and warning systems are put into use to prevent accidents involving the public.

Many questions will be answered during the course of the initial job survey. Will it be necessary to build detour or access roads or haul road crossings? Is there need for a flag person where traffic will cross the roads used by heavy equipment? Right-of-way locations, property easements, structures (in-place), machinery and utility locations must be investigated during the survey.

After gathering pertinent information, those persons responsible for the initial survey should develop a plan for proper equipment selection and maintenance. Checks for equipment safety standards required for each unit should be part of this plan. The company contracting to do the project must sit down with the persons doing the job-site survey, the project managers, superintendents, and so forth, and develop a safety program for the project that will ensure safe working conditions for their employees, engineers, and others associated with the project.

ACTIVITY 1:*

(Circle True or False.)

1. Job-site surveys may be conducted by anyone.

   True False

2. The reason for a job-site survey is to comply with the law or regulation only.

   True False

3. Soil conditions, timber, or rock will determine what equipment is used and the safety attachments of each unit.

   True False

OBJECTIVE 2: Cite at least five items that must be considered and perhaps protected before equipment operations begin.

There are several different utilities that may be located on a construction site that represent a potential danger to the equipment operators and support personnel. Operations must be carried out with strict regard for these utilities. Where applicable, danger signs should be posted (see Figure 1).

Overhead electrical power lines are a real danger to the operator. All lines should be considered energized unless there is a visible ground or they have been turned off by an authorized representative of the electric company.

*Answers to Activites appear on Page 29.

Electrical cables or transmission lines may be located underground. It is necessary to locate these on the project and take necessary steps to protect them and to protect persons from them. The operator must know in advance where the underground lines are located and the depth at which they are buried.

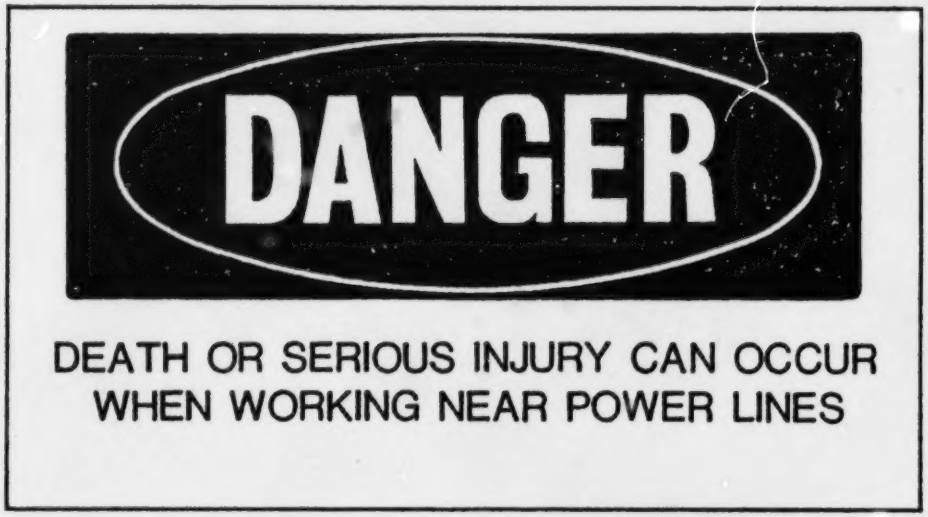

Figure 1. Danger sign for work near power lines.

Underground oil and gas pipelines crossing the project are another threat to the safety of the operator. For example, if a bulldozer should dig into a large gas line, the explosion and fire that could result would have serious consequences: injury or death of the operator, damage or destruction of equipment, and delay of project work. The location of such lines should be verified with the plans and clearly marked on the site. The operators must know the location BEFORE they start their actual construction. Oil companies often paint the fence posts a bright color where a pipeline intersects a fence (see Figure 2). This creates a marker visible to persons flying at low altitude as well as to persons driving along the ground. Problems may arise in looking for these fence post markings. Many times when a new road construction site is being planned, new right-of-way fences are erected before the project is started. The persons erecting the new fences may not paint the new posts that would indicate a pipeline

crossing. Those persons conducting the job-site survey should be sure these pipeline intersections are clearly marked and that the heavy equipment operator knows the depth at which they are buried. Remember, the greatest safety device in situations outlined above is the careful operator.

Figure 2. Pipeline intersections are often painted bright colors.

Other underground pipelines that are common problems where construction work is being done in or around towns and cities are water, sanitation, and steam (heat). These may not present as much immediate danger to the operator as would a natural gas line; however, it is very important that these be protected during construction work to avoid the high cost of repair (a direct cost to the contractor), to maintain good public relations and to prevent damage suits against the equipment owner or contractor.

Communication transmission lines, both above and underground, must be located and protected. A break in a major telephone cable could result in untold problems for individuals as well as for industry.

If the project is located within a city, it may be necessary to erect temporary fences or barricades around the project or project equipment (see Figure 3). Erection of temporary sidewalks or bridges may also be necessary. Work around existing buildings and structures will dictate certain safety steps that will need to be taken on each job situation.

Temporary fences may serve as a security barrier to keep the general public from the project. Young children are fascinated by heavy equipment;

therefore, the equipment should be locked and all the attachments should be grounded to protect the children from injury or death.

The security of fences and the locking of equipment also serves to protect the equipment to a certain extent from theft and vandalism. The Associated Equipment Distributors report that theft of heavy equipment results in losses of many millions of dollars each year. Special anti-theft plans

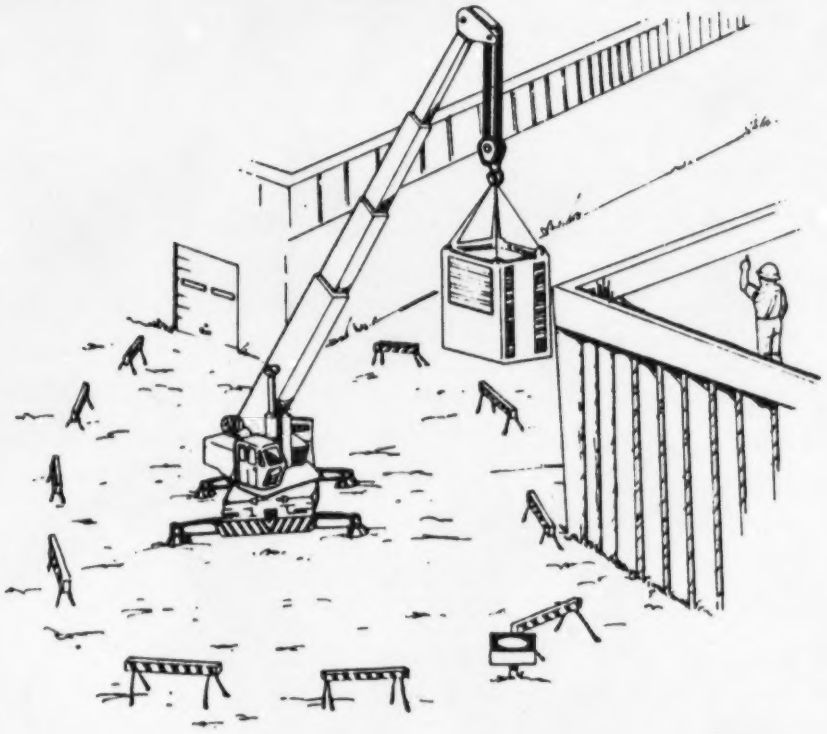

Figure 3. Temporary fences or barricades may be needed.

are in effect throughout the United States. The equipment owner should contact a local Associated Equipment Distributors member in the area for details and assistance in protecting equipment from theft. Also, the National Associated Equipment Distributor headquarters in Oak Brook, Illinois, is ready to help in any way possible.

ACTIVITY 2:

Name five things that must be considered or protected prior to the use of off-road heavy equipment.

1. _____
2. _____
3. _____
4. _____
5. _____

OBJECTIVE 3: State the purpose and process of the review and recommendation cycle of surveyed hazards and unsafe conditions.

A safety engineer with a major oil company made this statement more than 20 years ago: "There is no such thing as an accident. Had the person involved thought and then acted, the 'accident' would never have happened." There is a lot of truth in that statement. Initial job-site inspection is the process through which accident situations are thought out ahead of time.

The person in authority who was responsible for the initial job-site inspection must decide who will be responsible for each work area on the job. Persons such as the superintendent, the foreman, the bridge foreman, and so on, will be responsible for the process of review and recommendation that result from the survey. The survey will be the foundation for a good safety program. The safety program should include the orientation of construction workers and equipment operators to the hazards that exist on the project and the course of action that will be taken to ensure safe working conditions. Many construction companies employ a full-time safety inspector or engineer, who takes a very active role in the orientation and training of workers before heavy equipment is started. The careful selection of equipment that will do the work safely and economically is important. Each piece of equipment must have all the necessary OSHA (Occupational Safety and Health Administration) safety requirements. In the discussion with the operators and workers, their suggestions and ideas on safety and working conditions should be actively sought. These persons often have many years

of on-the-job work experience and can make vital recommendations concerning the safety hazards that were found in the survey.

ACTIVITY 3:

Name three groups of workers that should take part in the review and recommendation cycle.

1. _____
2. _____
3. _____

OBJECTIVE 4: Describe the way in which an employee awareness program works.

Safety is up to the person who performs a given job. The function of an employee awareness program is to be sure the employees know what to expect as regards working conditions on the job. Workers must know the types and kinds of equipment with which they will be working. Teamwork cannot be overstressed. The emloyee awareness program includes reviewing the work hazards of the job again and again and advising the employees of what is expected while working in and around these hazards.

The employees should be told of company policies and benefits, salary, overtime, union or open shop laws, and regulations imposed on the employees by the state and federal government. A good employee awareness program can ward off many labor and personnel problems later on. The awareness program should include safety training for employees that begins before work is started and continues during the course of employment.

Perhaps the key to an effective awareness program is to instill in the employees a sense of pride in their work. The total program can be lost if the employer and supervisors fail to recognize individual efforts and to let the employee know that these efforts are appreciated.

ACTIVITY 4:

Name four things that should be included in an employee awareness program.

1. _____
2. _____
3. _____
4. _____

OBJECTIVE 5: Identify the type and extent of medical and first aid support that should be available before working with off-road equipment.

Studies indicate that very little is being done to provide medical support on the majority of jobs that require the use of off-road equipment. First-aid classes may be offered on a few jobs; first-aid kits and instructions on their use and application may be a part of a course provided. If the project is large enough, a registered nurse may be employed. Perhaps the most important form of support is fast communication with the local ambulance service. Communication equipment is in the form of two-way radio units tied in with a base station that is manned during all working hours. The base station is equipped with telephone service to the local hospital and ambulance service. The law requires that employers ensure the ready availability of medical personnel for advice and consultation on matters of occupational health, and prompt medical attention should be available in case of serious injury. Prompt medical attention may mean a hospital close by, or a person at the work-site who has valid first-aid training from the U.S. Bureau of Mines, the American Red Cross, or some equivalent training.

ACTIVITY 5:

The most important medical support is fast communications with the local ambulance by means of _____ _____ and a base station.

OBJECTIVE 6: Name four hazards and their corrections, or preventive measures pertaining to the use of haul roads.

Haul roads may mean different things to different operators of off-road equipment. To the logger it may be a road, winding through the woods, whose primary purpose is to get logs skidded to the log trucks. After the trucks are loaded, they will move over much better haul roads to the main road or to the highways that lead to the mills.

If a haul road is to be used for moving heavy equipment, it may circle the steep hills, avoid wet or swampy areas, and push rocks to one side or bury them. The road will probably have only one lane and will provide turnaround points where the equipment will be unloaded.

The more familiar haul road is the temporary road that is built to accommodate large motor scrapers moving at speeds of up to 30 miles per hour. Large dump trucks hauling material from borrow pits or cuts to the fill section of the dams, roads, or fill sites for buildings or industry will also use this road.

Several things must be taken into account when building this road: the type of traffic it must accommodate, including size and weight (loaded); one way traffic or two lanes; the width of the road; the incline or grade; and the soil or rock conditions.

Several safety hazards may exist on the haul roads. Dust conditions, wet or slick roads, "pot" holes, loose rocks, snow and ice, narrow width, design of curves, and intersection with major roads and highways must all be considered.

Haul road construction will involve consideration of the width, curve, design, soil condition, and correct approaches to major roads. Width is determined by the width of the motor scrapers and dump trucks that will be using the haul road. In most cases, a haul road 60 feet wide will give a safe passing distance between equipment meeting or passing on the road. Curves should bank to the outside or have a superelevation built into the curve, as shown in Figure 4.

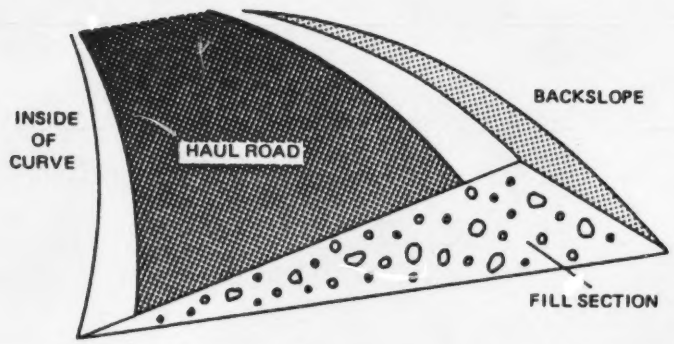

Figure 4. Banking of a curve.

Erection of warning signs, stop signs, yield signs, road intersections, warning lights, and so on, is very important to the safety of the haul road. Someone should be assigned the job of keeping the signs clean and in good working order, so that they can be seen by heavy equipment operators and truck drivers. Where trucks enter public highways, warning signs should be placed 750 feet from either side of the entrance. Drivers should be oriented to the use of the haul road, the rules of right of way, the signs, and the signals of the flagperson.

Harmful dust conditions can be kept to a minimum by watering and grading the haul road; however, the water truck driver must be careful not to get the road slick. Grading with a motor grader and watering the road can prevent "pot" holes, harmful dust conditions, rough roads, and can help to stabilize the road. It may be necessary to haul material to maintain the road in good safe operating condition.

Other potential dangers are snow and ice. The motor grader (blade) is used to clear snow and ice. Dirt should never be hauled when these conditions exist. Snow and ice can be kept to a minimum by constructing the haul road on the east and north sides of mountains or slopes when possible.

ACTIVITY 6:

1. Name four haul road considerations:
   a. _____
   b. _____
   c. _____
   d. _____

2. What two machines are used to control dust and maintain smooth haul roads?

   a. _____

   b. _____

OBJECTIVE 7: Discuss operator and driver qualifications and training.

The qualifications for operators of heavy off-road equipment vary from one company to another as well as from state to state within the United States. For example, in some states the operator must be licensed, while in others a union card is required that states that the operator is qualified to operate the specific type of equipment to be used. Companies may have their own training and certification programs.

For many years, formal training programs for operators of heavy equipment have been offered by some colleges and technical schools in the United States. Such programs offer specialized training on one piece of equipment, or general training on more than one unit.

Trade unions have an apprenticeship training program where a person may start out as an oiler or "swamper" and gradually learn the trade. However, there continues to be a shortage of qualified persons to operate heavy equipment. Too often persons are assigned to operate equipment for which they are not qualified. This represents a real danger for persons working with and around such operators. Lack of skills in operating could result in loss of lives and loss of millions of dollars in damage to equipment.

Truck driving, both on the road and off the road, requires a state license. Formal driver training programs are offered by private industry and by educational institutions. Despite the efforts of industry and schools alike, there is still a shortage of qualified operators and drivers with the experience that is needed.

The Construction Industry Manufacturers Association has prepared operator safety manuals that may be used in a training program. Even the safest machine must be operated with skill and a knowledge of its performance capa-

bilities, and a comprehensive safety program must be followed. The person who has the final responsibility is the operator.

To set up a good operator training program, a highly skilled operator with teaching abilities should be selected as an instructor. Tests designed to measure a person's mechanical aptitude and manual dexterity can be used to screen and select potential student operators.

The initial job-site survey can guide the selection of representative types of equipment that will be used on the job. This equipment should be in good mechanical condition, and have the required safety equipment, such as roll-over protection structures (ROPS), cabs, seat belts, a back-up alarm, boom angle indicators, boom stops, and so forth. The safety instruction program should be set up around these types of selected equipment.

The basic instructional program designed to train the operators may be outlined as follows:

I. Safety
   - A. Know your employer's safety program.
   - B. Dress properly for the job.
   - C. Know signals and traffic rules.
   - D. Practice safety at all times.

II. Pre-Starting Checks
   - A. Check machine and attachments; walk around machine to do this.
   - B. Check engine and transmission oil levels.
   - C. Check coolant.
   - D. Report necessary repairs.
   - E. Check area.

III. Starting and Shutdown Procedures - Check Manufacturer's Operators' Manual

IV. Machine Operations (Under Supervision of Instructor)
   - A. Basic operations.
   - B. Advanced operation on machinery assigned (as the student progresses).
   - C. Preventive maintenance.

It may take two years or more of work experience for the individual to develop the skills and competencies needed to become a first class operator.

ACTIVITY 7:

Name four major units of instruction that make up a good basic operator training program.

1. _____
2. _____
3. _____
4. _____

OBJECTIVE 8: List three precautions to be used when operating trucks near workers.

Operators should be aware of other workers in the area where equipment is in motion. There is the danger to other workers of being struck or run over by power shovels, concrete mixers, and other types of trucks. A basic part of preventing equipment accidents is the maintenance of all equipment in a state of good repair. The necessary daily maintenance and repair should be performed by the driver or the person designated to take care of the daily servicing of the rigs.

Back-up alarms are required for trucks that have an obstructed view to the rear. According to OSHA, back-up alarms must be audible above the surrounding noise. A dealer can advise which types of alarms meet OSHA requirements and which kind is most appropriate for the operating condition and application of the trucks in a given fleet. If back-up alarms are not used where the rear view is obstructed, then a signal person must direct the backing of the vehicle. Another type of vehicle equipment that protects workers in the area as well as the driver is the service braking system. This system must be capable of stopping and holding the equipment when it is fully loaded.

The driver is the key to safety. The driver should make a visual check of the area and know what fellow workers are doing. When backing the truck into position, the driver should use a signal person who can see the back of the truck at all times and can be seen by the driver at all times in the rear-view mirror. The hand signals used by the signal person should be standard and known to the operator.

Good operating techniques are helped by adequate turning radius barricades that indicate the edge of cuts where bridge construction or similar work is being done. When the driver is backing up to a warehouse or similar structure, some type of physical barrier should be constructed to limit the backward motion of the rig. This barrier should be constructed so it will not damage the equipment or the building.

Lighting requirements for vehicles include head, turn, tail, stop, clearance, back-up, and hazard warning lights, along with warning lights for any system on the rig. A complete check of the lights is a "must" on the operator's pre-starting check list.

ACTIVITY 8:

(Circle True or False.)

1. The signal person should be in a position to see the back of the truck and be visible to the driver in the rear-view mirror when the driver is backing a truck into position.

   True False

2. The mechanical condition of the vehicle is the key to safety.

   True False

OBJECTIVE 9: List three good practices to be employed when driving on dumps.

Many dangers exist on construction sites where there are cuts and fills. Driving too close to the edge of a "fill" or dump can cause the dirt to give way and the truck to slide off the dump. The height and slope of the dump may make the difference in whether the truck slides off or turns over on its side. The stability of the dump as the dirt is being unloaded can give clues for determining the safe driving distance from the edge of the dump. The stability depends upon the type of soil and the soil condition. Loose sand can cause the dump to give way and the truck to slide sideways. If the dump is wet or slick, semitrailers may jackknife, and all types of trucks can get stuck on the fill.

If a dump truck slides off the side of fill and gets stuck, dumping the load may cause the truck to turn over. The safest way to handle this situation would be to tie a winch line or a "tow" cable to the front frame of the truck on the high side, and pull at an angle toward the top of the fill.

When dumping off the edge of a fill, the driver should back so that both rear wheels will be the same distance from the fill (see Figure 5).

Figure 5. Rear wheels should be equidistant from the fill when the truck is dumping off the edge of the fill.

Certain rear dump semitrailers can be backed over the edge of the fill. However, it may be necessary to keep six or eight feet back from the edge if the fill is soft, slippery, sandy, or otherwise treacherous. The correct dumping procedure is given below:

1. With the truck in the correct dumping position, place the selector (hydraulic) valve in the raise position and release the gate lock.
2. After the dump is made, drive forward; this will spread the dirt.
3. Be sure the dump bed is lowered before starting back to get the next load. Caution: A loaded body should not be raised unless the rear wheels are level.

As mentioned previously, often a trained "dumpman" directs the driver. This person uses prearranged signals to give the driver instructions in backing.

ACTIVITY 9:

Name three things to watch out for or do when driving or dumping on a fill.

1. _____
2. _____
3. _____

OBJECTIVE 10: Describe the uses of each of the five types of protective equipment on heavy equipment.

The roll-over protection structure (ROPS) is designed to support the concentrated weight of the machine in the event that it rolls over. The purpose of the ROPS is to protect the operator from being crushed by the machine. This cab may also prevent the machine from rolling over should it turn on its side. It is essential that each cab be approved for the particular machine on which it is to be mounted. All welding on special mounts must be done by a certified welder. The equipment manufacturer's instructions must be followed in mounting a unit that was not installed at the factory.

Seat belts are installed to restrain the operator from falling off the machine should an emergency arise. These are required on all vehiclesthat are operated from a seated position, unless the equipment is not provided with a ROPS unit.

Back-up alarm units are installed to warn other workers in the area that the machine is backing up. They should be kept in good working order.

Safety locks are placed on the equipment to lock automatic transmission and the directional lever in the neutral position while the machine is being started, or when the operator leaves the machine with the engine running. Some machines provide a way to padlock this guard in place in order to protect against vandals or to prevent unauthorized people from operating the machine.

Bulldozers that are going to be used in land clearing require the special installation of a hardware screen across the back and sides of the ROPS canopy (including access doors on the sides). In addition to this, special

side panels are made to protect the engine, and special grills are designed to protect the radiator.

Some equipment manufacturers make available a special vandalism "package" for machines that do not have enclosed cabs with locking doors. This package provides ways to protect the gages and instruments, as well as the locked filler cap for hydraulic and fuel tanks. The engine oil filler and radiator caps are also protected.

Other support equipment used on construction jobs should have the necessary safety equipment installed. For example, jeeps should have special roll bars and safety belts. The equipment owner, operator, and the safety inspector may design special guards and equipment. It is important to remember that safety equipment is of no value unless it is used and maintained in good working order.

ACTIVITY 10:

Name three kinds of protective equipment installed on heavy equipment.

1. _____
2. _____
3. _____

OBJECTIVE 11: List three problems encountered when transporting workers on heavy equipment and trucks.

Workers should never be transported on heavy equipment. They should not ride on draw bars, in loader or shovel buckets, or on motor scrapers. Occasionally, it will be necessary for the "stake" runner to ride on the motor grader. In these cases, the rider should be inside the cab with the operator. The same rule holds true in heavy equipment training situations when the instructor or student must ride on the equipment together. Caution should be exercised in these cases, even when the training equipment is equipped with a special seat.

Transporting workers in trucks presents a problem when the workers cannot get inside the cab. If they are to be transported on the truck beds,

side boards should be installed and some type of seats should be built. Equipment and workers should not be hauled together because the loose equipment represents a real safety hazard. This type of temporary transportation should be restricted to "on the job." If transportation is to be provided to and from the job, and the workers cannot ride in the truck cabs, then a bus should be used.

Workers should never "hitch" rides on the outside of moving trucks and pickups. The greatest danger in their doing so is that of falling under the wheels.

ACTIVITY 11:

Workers may be transported on heavy equipment in all except which of the following special circumstances?

a. In a training situation.

b. When being transported to and from the job site.

c. When seats are provided in truck beds and no loose equipment is being hauled together with the workers.

d. In cases where the "stake" runner needs to ride in the cab with the operator.

OBJECTIVE 12: List three safety practices to use when towing.

Towing can be a dangerous operation. Workers other than the operator should be clear of the area where towing is taking place. Under no circumstances should any person go between the vehicles involved while either one is in motion. The brakes should be set or the wheels blocked to prevent unwanted movement of the vehicles before the operation is begun. The driver should be alert to the presence of other workers and should receive an all-clear signal before moving. The hazard to workers standing by a towing operation is not only that of being crushed between the two vehicles, but also that of being hit by a broken cable.

In general, tow bars are safer than towing cables. When towing or pulling a piece of equipment with cable, the cable or winch line must be

large enough to handle the load. Guards should be installed to protect the operator when winch cables are in use. When using a long cable for towing, the operator should move forward and take up the slack slowly, taking care not to jerk or kink the cable. When inspecting tow cables, check for wear, broken wires, deformation, kinks, and so on. Chains should not be used in towing heavy equipment because of the danger of breakage and flying links.

If one must tow a motor grader in which the engine is dead, it will be necessary to run an air line from another piece of equipment in order to have brakes on the machine being towed. This would also apply to a truck if the engine is not running. If the engine is dead, the power steering is also out and steering the machine can only be accomplished by releasing the hydraulic valves in the steering system.

ACTIVITY 12:

List three safe practices to use when towing.

1. _____
2. _____
3. _____

OBJECTIVE 13: Discuss three procedures valuable to safety concerning power shovels, cranes, and similar equipment.

When it comes to safety in operating power crane and shovel equipment, the attitude and skill of the operator makes the difference. The most important procedure to follow to ensure safety in working with this equipment is the screening and selection of potential operators. Persons who operate or use cranes or power shovels must possess the following characteristics:

- Competency and emotional stability sufficient to withstand stress and to prevent accidents.
- Physical capability of reacting quickly and accurately to avoid accidents.
- Mental capability of understanding established rules, regulations, and safety practices, and applying these skills and knowledge to every work situation.

Operators should be trained in the safe operation and maintenance of the machine. They should read the instructions manual that covers such things as load rating charts and standard hand signals. In some states an operator must be licensed.

Equipment maintenance and inspections go hand in hand with a good safety program. Causes of accidents involving power shovels and cranes can be classified in the following categories:

1. Improper selection of equipment as to size and type.
2. Human (operator) error.
3. Equipment malfunction or failure.
4. Hazards in the work area.
5. Other workers in the area.

The objective of the maintenance program is to properly inspect, service, adjust, and repair, lubricate, and test equipment to ensure safe, economical, and productive operations. A complete annual inspection of the hoisting machinery must be made by a competent person or a government agency recognized by the Department of Labor. The employer must keep accurate data as to date and results of the inspection. Additional inspec-tions are required and detailed in American National Standards Institute B30.5-1968.

Wire rope is used in both power shovel and crane equipment. Running ropes, or lines that are load bearing require constant inspection for wear, broken wires, kinks, deformation, and so forth. Replacement requirements are specified in both OSHA Part 1910, and Part 1926, and in American National Standards Institute B30.5-1968. These are excellent standard requirements; they have been incorporated into the OSHAct by reference and should be closely followed.

When a crane is in place and ready to make a lift, the operator and rigger should clear all personnel from the area. A load should NEVER be lifted over other workers.

Working in the vicinity of electrical power lines presents a very serious safety hazard; therefore, special precautions must be taken. Safe operating practices require that the maximum possible distance be maintained between the machine and the wires, and that the minimum clearances never be

exceeded. There are local, state, and federal regulations regarding work in the area of power lines. Listed are some examples of clearance regulations:

- Lines rated 50 kV (kilovolts) and below - minimum clearance between the lines and any part of the machine or load shall be 10 feet.
- Lines rated over 50 kV minimum - clearance between the lines and any part of the crane shall be 10 feet plus 0.4 inches for each 1 kV over 50 kV.

Heavy equipment may become electrically charged when it is moving or parked in the vicinity of high frequency transmitters. Remember - serious injury or death can occur when working near power lines. (Figure 6.)

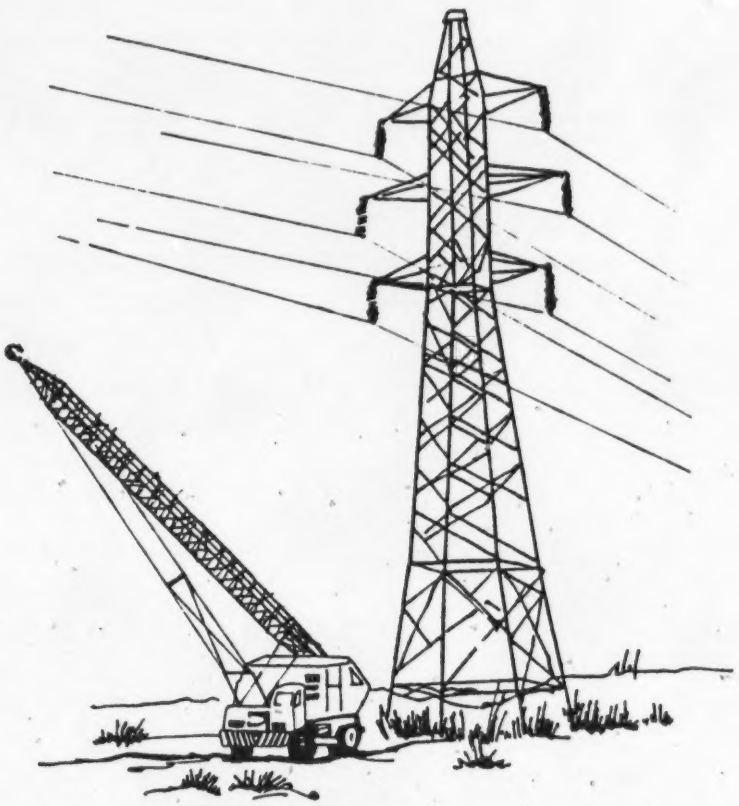

Figure 6. Clearance must be maintained when cranes are operated in the vicinity of power lines.

ACTIVITY 13:

Which of the following is not a major safety consideration related to power shovels, cranes, and similar equipment.

a. Other workers in the area.

b. Selection of the operator.

c. Size of structure in progress.

d. Clearance between power lines.

e. Maintenance of equipment.

OBJECTIVE 14: Discuss safe practices when handling loads with mobile cranes.

Safety inspection of the equipment is very important before a "lift" is made. The boom, wire rope, and hook block must be checked. If a cable rig is to be used, the boom safety must be checked, the stops kicked out, and the general mechanical condition of the machine checked. All rubber-tired cranes must have outriggers. The operation and condition of the outrigger must be checked whether they are mechanically or hydraulically operated.

The operator must check the area where the lift is to be made, examining ground conditions, obstruction of the boom or suspended load, and electrical lines. Then the crane can be moved into place and a "dry run" can be undertaken. The signal person should be present to check the boom clearance area.

Another responsibility of the operator is to know how to read the lifting capacity charges, how to use the boom angle indicator and how to apply this information to the operation and position of the machine before the load is lifted.

The Power Crane and Shovel Association (PCSA), a bureau of the Construction Industry Manufacturers Association (CIMA), has long been recognized as a leader in the ratings of cranes for lifting capacities. A few basic terms that are used in determining these load capacities are defined as follows:

1. Load radius - the horizontal distance from the center of rotation of the crane to the center of gravity of the suspended load.

2. Tipping load - the total suspended weight required at a given radius to cause the machine to tip.

3. Counterweight - weights attached to the rear of the revolving frame of the crane to increase stability and capacity.

4. Rated load - the total weight that can be safely suspended at a given radius determined by a percentage of the tipping load, or the machine's structural competence as determined by the manufacturer.

All ratings are based on the load freely suspended. Cranes are not intended for side-loading (see Figure 7). In side-loading, the hook is suspended at an angle, rather than directly over the load, and this leads to accidents.

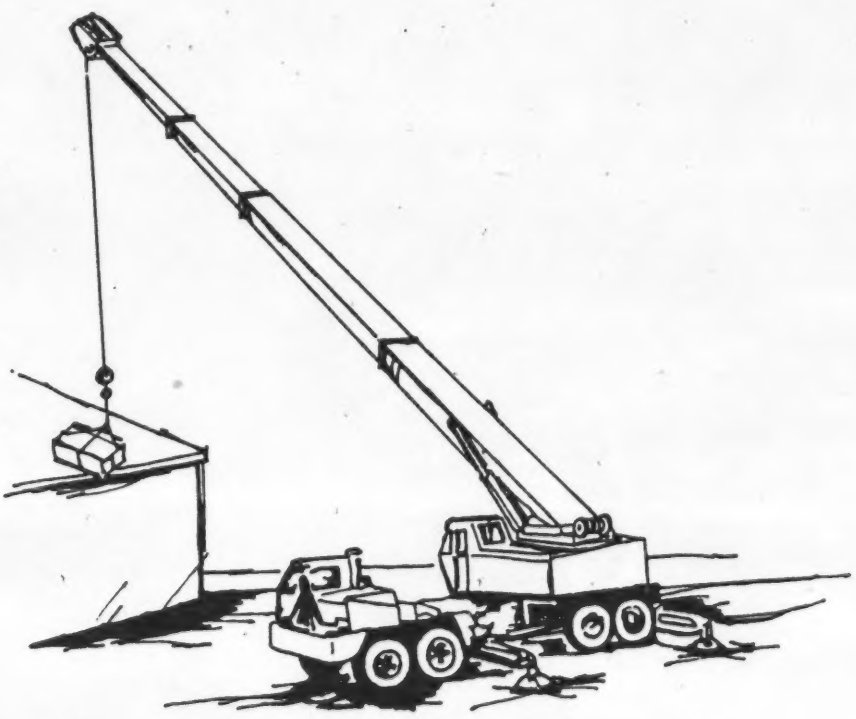

Figure 7. Cranes are not intended for side-loading. The hook should be suspended directly over the load.

Accidents caused by side-loading are the result of these improper practices:

- Wind forces on boom and load areas.
- Dragging a load.

- Acceleration or deceleration in swinging a load.
- Dragging or pushing a load.

Before lifting the load, the hook must be vertical over the center of the load. Only one signal person using the nationally recognized hand signals shown in Figure 8 should be used.

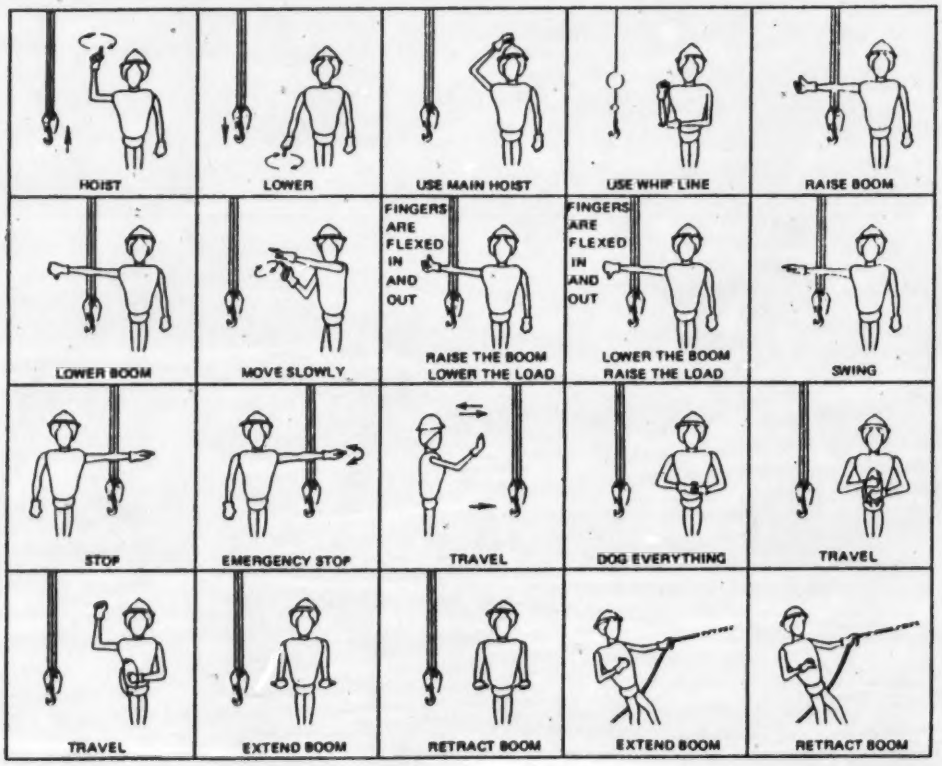

Figure 8. Standard hand signals used in operating power cranes or shovels.

A load must never be lifted over other workers. If two machines are to be used in lifting one heavy load, the lifting plans must be coordinated with both operators, using only one signal person. The slings must be rigged to equalize the load, and the capacity must not be exceeded on either machine.

Two separately rigged loads must never be hoisted at once. The load must be under control at all times. It may be necessary to use hand lines to guide or snub a load. These lines must not be wrapped around the body, hands, or arms since it may be necessary to release these lines in a hurry.

ACTIVITY 14:

Define the terms:

1. Load radius: _____

   _____

2. Tipping load: _____

   _____

3. Side loading: _____

   _____

OBJECTIVE 15: Discuss the use of personal protective equipment when operating motor graders, bulldozers, and scrapers.

Motor graders, bulldozers, and motor scrapers operate in noisy, dirty, dusty, and often unsafe working conditions. Every employer should have some type of safety program. It is the responsibility of the operator to know what is included in this program. Check with the foreman or safety supervisor to see what personal protective equipment is required for the job.

The personal protective equipment used in construction work is listed here:

- Hard hat.
- Safety-toed shoes.
- Safety goggles - glasses.
- Heavy gloves.
- Respirators.
- Ear protectors.
- Reflector vests.

Operating conditions usually dictate what items of equipment are to be used. For example, extremely dusty conditions would require the use of safety goggles as well as respirators. The operator must keep in mind that this equipment is for one's personal safety and benefit, as well as for the safety of those working around the operator.

If the noise level inside the cabs or ROPS canopies reach 85 decibels, the operator should be offered the use of ear protection. At 90 decibels ear protection is required; there is a new OSHA regulation making ear protection equipment mandatory as of April 21, 1981.

Clothing should be comfortable, not loose or dangling. Watches or rings should not be worn since they may catch in moving parts.

Safety is up to the individual worker. The use of personal protective equipment may determine the operator's personal safety as well as the safety of other workers in the area. Blinding dust could result in collisions of equipment with serious injury or death to the operators and others.

ACTIVITY 15:

List the personal protective equipment used by operators of motor graders, bulldozers, and motor scrapers.

1. _____
2. _____
3. _____
4. _____
5. _____

REFERENCES

Brannan, Charlie and Schwer, Geof. Modular Heavy Equipment Operator Training Program. Waco, TX: Texas State Technical Institute.

Nichols, H.L. Modern Techniques of Excavation. Greenwich, CT: North Castle Books.

Nichols, Herbert L., Jr. How to Operate Excavation Equipment. Greenwich, CT: North Castle Books.

Safety Manuals. Milwaukee, WI: Construction Equipment Manufacturers Association, 1970.

Wallace, James L. Mobile Cranes - Positive Planning Produces Profit. Houston, TX.

ANSWERS TO ACTIVITIES

ACTIVITY 1

1. False.
2. False.
3. True.

ACTIVITY 2

1. Overhead electrical power lines.
2. Underground cables.
3. Oil and gas pipelines.
4. Communication lines.
5. Existing buildings and structures.

ACTIVITY 3

1. Operators.
2. Foremen.
3. Superintendents.

ACTIVITY 4

1. Company policies and benefits.
2. Salary and overtime.
3. Union or open shop laws.
4. Review of work hazards.

ACTIVITY 5

Two-way radio units.

ACTIVITY 6

1. a. Width.
   b. Curve.
   c. Design.
   d. Soil conditions.
   e. Correct approach to major roads.

   (Choose any four of these five.)

2. a. Motor grader.
   b. Water truck.

ACTIVITY 7

1. Safety.
2. Pre-starting checks.
3. Starting and shut-down procedures.
4. Machine operations.

ACTIVITY 8

1. True.
2. False.

ACTIVITY 9

(Any three of these four.)

1. Keep rear wheels equidistant from the fill.
2. Consider soil composition in determining how close to the fill the truck may safely maneuver (6 to 8 feet back if fill is sandy).
3. Lower dump bed before going back to get next load.
4. A loaded body should not be raised unless the rear wheels are level.

ACTIVITY 10

1. ROPS.
2. Seat belts.
3. Safety locks.
4. Hardware screen.
5. Side panels.

(Any three of these five.)

ACTIVITY 11

b. When being transported to and from the job site.

ACTIVITY 12

1. Keep other workers away.
2. Set brakes or block wheels to prevent unwanted motion.
3. Use a bar where possible.
4. If using cable, take up slack slowly.

(Any three of these four.)

ACTIVITY 13

c. Size of structure in progress.

ACTIVITY 14

1. Long radius - the horizontal distance from the center of rotation of the crane to the center of gravity of the suspended load.
2. Tipping load - the total suspended weight required at a given radius to cause the machine to tip.
3. Side loading - the suspension of a load at an angle to the top of a crane boom.

ACTIVITY 15

(Any five.)

1. Hard hat.
2. Safety-toed shoes.
3. Safety goggles - glasses.
4. Heavy gloves.
5. Respirators.
6. Ear protectors.
7. Reflector vests.